CropLife INTERNATIONAL

Representing the Plant Science Industry

Technical Monograph 2003

Anticoagulant Resistance Management Strategy For Pest Management Professionals, Central And Local Government And Other Competent Users Of Rodenticides

Technical Monograph 2003

Anticoagulant Resistance Management Strategy For Pest Management Professionals, Central And Local Government And Other Competent Users Of Rodenticides

Rodenticide Resistance Action Committee

TABLE OF CONTENTS

AIM

This document seeks to provide guidance to advisors, authorities, professionals and others on both the application of rodenticide use strategies that will avoid the development of resistance, and the recognition of anticoagulant resistance and how to manage it.

INTRODUCTION

It has now been shown over some fifty years that the use of anticoagulant rodenticides forms the most effective method of controlling commensal rodent populations.

The continued use of these anticoagulant rodenticides has however led to the development of resistance in some of the commensal rodent species. Such resistance is restricted geographically.

Remember, resistance is characterised by the ability of individuals within a rodent population in the field to continue feeding on the anticoagulant bait over many weeks, without being killed. It is not characterised by the reluctance of the rodents to feed on the baits.

Continuous feeding from anticoagulant baits may not only be due to resistance, but may also be caused by under-baiting or immigration. However, once these alternatives have been eliminated the probability that the cause of the continued feeding activity is anticoagulant resistance is high.

From the point of view of those undertaking field rodent control the term Practical Resistance is used to identify resistance that has led to the difficulty to control rodents in field situations.

> "Anticoagulant resistance is a major loss of efficacy in practical conditions where the anticoagulant has been applied correctly, the loss of efficacy being due to the presence of a strain of rodent with a heritable and commensurately reduced sensitivity to the anticoagulant". Greaves, 1994*.

* Greaves, J.H. (1994): Resistance to anticoagulants. In: Buckle, A.P. and Smith, R.H.: Rodent pests and their control. CAB International, Wallingford, UK.

1 GENERAL INSTRUCTIONS ON THE CORRECT USE OF RODENTICIDES

BACKGROUND

The three most cosmopolitan rodent pest species are

- Ship (black, roof, fruit, house) rat - **Rattus rattus**
- Norway (brown, sewer, common) rat - **Rattus norvegicus**
- House mouse - **Mus musculus spp**

Here lies the key issue in any effective rodent control programme, "know the species"!

Each species has distinct behavioural and ecological requirements that must be clearly understood if effective management is to be achieved. The control techniques available must be clearly targeted to the characteristics of the species concerned. Mis-identification or failure to appreciate these characteristics will reduce the chances of effective control significantly.

The problems caused by rodents should not be seen as the problems of individuals, but as community problems that need to be addressed by the community as a whole. Attempts to solve rodent infestation across wider areas needs to be addressed on a community basis if the efforts are to be cost effective.

The effective control of rodent infestations should not be treated simply as a question of killing the rodents. The problem must be seen more broadly, as an infestation within a vulnerable environment.

The control strategy should be developed both in terms of reducing rodent numbers but also in terms of managing the environment. This will not only prevent the development of the rodent population but also prevent rodents within that environment coming into conflict with man and his interests.

The name given to this "total environment" approach to rodent control is termed **Integrated Pest Management (IPM)** and incorporates three main components

- Habitat management
- Control of rodent movement through proofing
- Control of the rodent population using appropriate chemical and physical control measures.

Before any IPM is undertaken it is first essential to understand the nature of the problem through the completion of a comprehensive survey and inspection of the area/s concerned. The objective of this survey is to identify

- The species involved.
- The extent of the infestation three dimensionally (horizontally and vertically).
- The severity of the infestation (roughly how many rodents there are).
- Where the rodents have come from.
- The harbourage being used.
- The food source(s) being used by the rodents.
- Non-target hazards and associated risks.

Only once these components have been identified can an effective IPM strategy be developed.

HABITAT MANAGEMENT

For a rodent infestation to thrive there must first be an environment that provides the three main features that rodents require. These are

- Food
- Harbourage
- Water (free water not necessarily required by house mice)

Therefore removing these components of the habitat as far as is practicable, or protecting them from access by rodents will make it less likely to be infested by commensal rodents.

EXCLUSION AND PROOFING

In situations where the rodent problem is caused by rodents moving from one area to another, it may be possible to prevent the rodents reaching the vulnerable crop, store, processing unit or building by the simple expedient of ensuring that physical barriers are placed in their way.

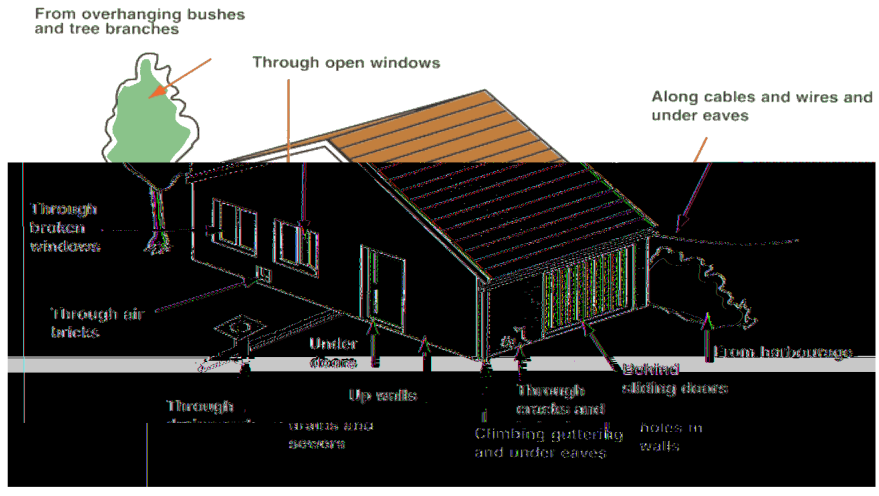


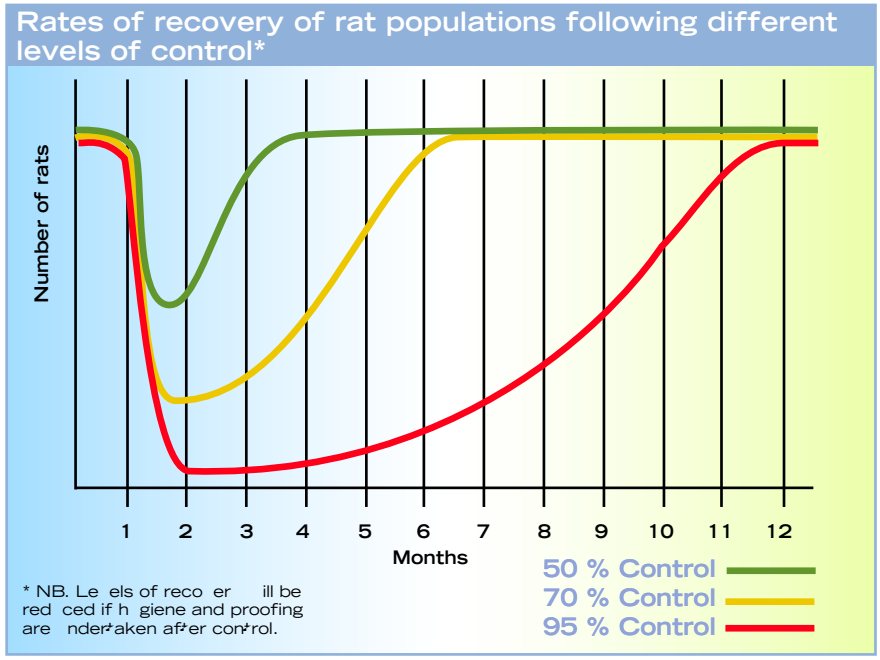
Figure 1: Potential rodent access routes into a building.

Mice are so small ⁺he can also be 'deli ered' in⁺o premises in infes⁺ed goods, e.g. inside a palle⁺ con⁺aining sacks of grain or processed food prod c⁺s. In s ch cases, ⁺he areho se or food s⁺ore sho ld ha e adeq a⁺e 'q aran⁺ine' proced res ⁺o inspec⁺ incoming goods for e idence of mice.

CONTROL

One of ⁺he ke charac⁺eris⁺ics ⁺ha⁺ make roden⁺s s ch s ccessf l mammals and pes⁺s is ⁺heir abili⁺ ⁺o breed er rapidl . Whils⁺ ⁺he reprod c⁺i e ra⁺es of indi id al species ill ar , a ⁺ pical female commensal roden⁺ can prod ce an a erage of eigh⁺ o ng e er mon⁺h! Th s, ⁺o achie e effec⁺i e con⁺rol high le els of mor⁺ali⁺ are req ired, o⁺her ise pop la⁺ions ill re⁺ rn rapidl ⁺o ⁺heir pre-con⁺rol le els and ⁺he con⁺rol opera⁺ions ill no⁺ be cos⁺ effec⁺i e, see fig. 2.

Figure 2: Ra⁺es of reco er .



The mos⁺ cos⁺ effec⁺i e ⁺echniq e for con⁺rolling commensal roden⁺ pop la⁺ions is ⁺o se chemical roden⁺icides. I⁺ is essen⁺ial ho e er ⁺ha⁺ ⁺hese are sed safel so ⁺ha⁺ non-⁺arge⁺ species are no⁺ harmed ei⁺her ⁺hro gh primar or secondar poisoning.

Chemical Control

The de elopmen⁺ of ⁺he **chronic anticoagulant** roden⁺icides in ⁺he earl 1950s and s bseq en⁺l has re ol ⁺ionised roden⁺ con⁺rol. Wi⁺h ⁺he chronic roden⁺icides 100% mor⁺ali⁺ became ⁺he e pec⁺a⁺ion ra⁺her ⁺han ⁺he e cep⁺ion and ⁺hese chronic roden⁺icides are no ⁺he mos⁺ idel sed gro p of roden⁺icides.

They achieve their effect by interfering with the blood coagulation in the rodents that feed on them, resulting in death by haemorrhage. The particular advantage of these anticoagulants is that they have a delayed action and the minimum time to death is 2 days, with most deaths occuring between days 4 and 7. This delayed action prevents the rodent associating its illness with the rodenticide until it has consumed a dose of anticoagulant large enough to ensure it will die. The objective when using these chronic rodenticides is therefore to ensure that all rodents are able to feed at the bait points.

Anticoagulant rodenticides available worldwide

Warfarin Chlorophacinone Coumachlor Diphacinone Coumatetralyl	First Generation Anticoagulants
Difenacoum Bromadiolone Difethialone Brodifacoum Flocoumafen	Second Generation Anticoagulants

It is essential that the anticoagulant rodenticide is placed in such a way as to ensure that the target rodents are able to feed on the baits, but that children and non-target species do not have access to the bait

- by using suitable materials available on site to cover and secure bait points,
- by using commercially available tamper-resistant bait stations,
- by using self made bait stations,
- by placement only in secure premises,
- by placing baits in areas inaccessible to non-target species,
- by undertaking frequent visits to the site.

Remember that before using an anticoagulant rodenticide

- only use a product that has been approved in the country of use,
- read the label and follow the directions for use,
- undertake risk assessments relating to both the safety of the user, the environment and non-target species.

Remember when using an anticoagulant rodenticide

- to place the bait in areas of rodent activity identified in the survey ,
- ensure that revisits are made to the baiting points at weekly intervals or more frequently where necessary ,
- prevent non-target access to the baits ,
- replenish eaten bait at the revisits as instructed on the label
- search for dead and dying rodents at the revisits and dispose of these safely ,
- when dead and dying rodents are being found frequently , increase the frequency of the re-visits , to reduce potential impact on the environment,
- ensure that no spillage of bait is taking place and remove any spillage that does occur ,
- wear the protective clothing recommended on the label,
- inform those living and working in the area of the rodent treatment,
- keep records of bait placement and monitor bait consumption at revisits .

Remember after completion of the anticoagulant treatment

- remove all surplus baits
- the baiting positions may be left in place as monitoring points or to reduce neophobic response during subsequent treatments
- non toxic or placebo baits may be left in position to assist with the monitoring for rodent activity apply environmental, proofing and hygiene
- requirements as a part of the Integrated Pest Management strategy
- store all anticoagulant rodenticides safely
- complete the records to assess the success of the treatment.

Where the anticoagulant rodenticide is used correctly 100% control of the rodents should be achieved. However if the infestation is proving persistent follow the Checklist for Anticoagulant Rodenticide Users (Appendix 1).

Record K eeping

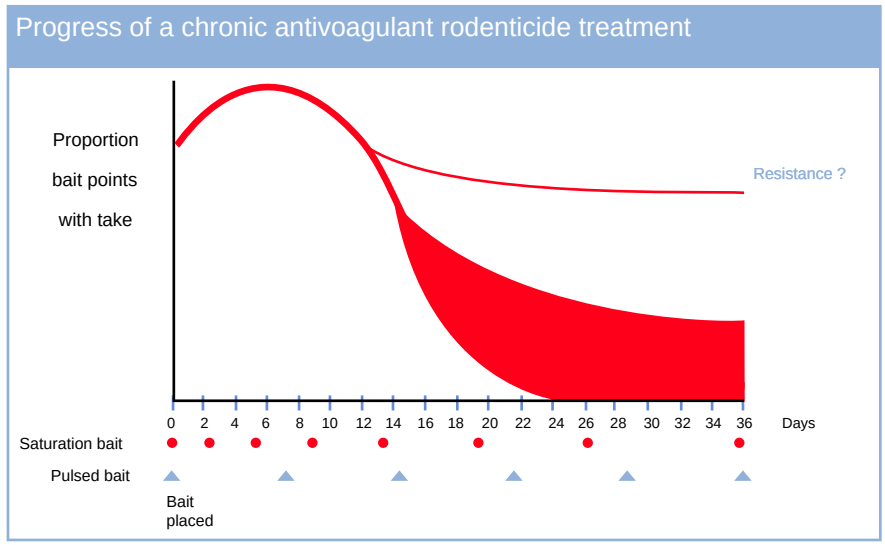
It is essential to maintain effective records throughout the treatment, these should include the following elements

- positions of all bait placements ,
- record details of bait used,
- quantities of bait laid,
- details of visits to check and replenish baits ,
- bait consumption determined at revisits ,
- details of IPM strategy implementation.

The maintenance of an effective record keeping system enables the more reliable determination of the progress of the control operations and the determination of the causes of treatment failure , including resistance .

If necessary the records may be plotted in a form similar to F igure 3 to determine progress with the treatment.

F igure 3: Progress of treatment.



2 RECOMMENDATIONS FOR THE TREATMENT OF POPULATIONS CONTAINING RESISTANT INDIVIDUALS

PRACTICAL RESISTANCE

Early evidence of resistance in house mouse and Norway rats involved first generation anticoagulants warfarin and diphacinone. In such cases, it was not possible to control the rodents with these rodenticides.

Subsequently, laboratory studies have produced a series of tests to identify resistance against a range of active ingredients. However, many of the tests are very sensitive, and the level of resistance they identify may not be sufficient to affect practical control. This is particularly the case for the second generation anticoagulants. The term "Technical Resistance" is used to describe such resistance.

Recent work funded by RRAC of CropLife International and published on the web site (www.croplife.org, at library, monographs) is the first practical attempt to address this issue. Susceptibility baselines and tests have been developed for nine active ingredients against Norway rat, and five active ingredients against house mice, which allow the determination of a Resistance Factor as a measure of the level of resistance.

Resistance Factor is simply the multiple of the baseline dose required by the non-resistant, susceptible, animal that achieves the same response in a resistant animal. These tests can be used to give a clear indication of the likely practical impact of the resistance on field efficacy.

With Practical Resistance, Resistance Factors are high and treatment outcome is adversely affected; with Technical Resistance, Resistance Factors may be low, and there is not necessarily a discernible affect on treatment outcome.

For the Field Technician, the first evidence of Practical Resistance will be high bait consumption records on the third and subsequent weeks of treatment (Fig 3). The assessment of the number of bait points with take on each bait application (plotted as indicated on Fig 3), is a simple method requiring minimal additional effort, that can be used to provide evidence of Practical Resistance, although it should be remembered that under-baiting and immigration can have a similar effect on overall bait take; and that immigration may be difficult to assess in the field.

STRA TEGIC USE OF RODENTICIDES

The important issues here are firstly to identify strategies for avoiding the development of resistance in susceptible rodent populations and secondly to identify strategies for managing resistance to the anticoagulants when it is suspected or identified.

Remember that the normal strategy used for managing resistance in populations of insects , weeds or other pests is to rotate the control between different groups of pesticide , targeting as they do , different control mechanisms .

Unfortunately , the anticoagulant rodenticides all work in much the same way and the nature of the resistance to the different anticoagulants is so similar that simply rotating between the anticoagulants is not a reliable means of managing anticoagulant resistance . However , using anticoagulants of higher toxicity plays a major part in resistance management. In case of confirmed practical resistance , an anticoagulant rodenticide of higher toxicity compared to that, which is hit by resistance , should be used to eradicate the infestation. In some cases , especially with mice , alternations with non-anticoagulants can be part of the strategy .

SUMMAR Y

TO AV OID THE DEVELOPMENT OF RESIST ANCE iN SUSCEPTIBLE RODENT POPULA TIONS

- Use anticoagulant rodenticides . Ensure that all baiting points are inspected weekly and old bait replaced where necessary .
- Undertake treatment according to the label until the infestation is completely cleared.
- On completion of the treatment remove all unused baits .
- Do not use anticoagulant rodenticides as permanent baits routinely . Use permanent baits only where there is a clear and identified risk of immigration or introduction or where protection is afforded to high-risk areas .
- Monitoring of rodent activity should be undertaken using visual survey , through the use of non-toxic placebo monitors or by other effective means .
- Record details of treatment.
- Where rodent activity persists due to problems other than resistance , use alternative baits or baiting strategy , extend the baiting programme or apply alternative control techniques to eliminate the residual infestation (acute or sub-acute rodenticides , gassing or trapping).
- Ensure that complete elimination of the infestation is achieved.
- As appropriate during the rodenticide treatment apply effective Integrated Pest Management measures (remove alternative food sources , remove water sources , remove harbourage and proof susceptible areas against rodent access).

TREA TMENT OF RODENT INFEST ATIONS CONT AINING RESIST ANT INDIVIDU ALS

- Where rodent infestations containing resistant individuals are identified, immediately use an alternative anticoagulant of higher potency . If in doubt, seek expert advice on the local circumstances .
- Alternatively use an acute or sub-acute but non anticoagulant rodenticide .
- In both cases it is essential that complete elimination of the rodent population is achieved. Where residual activity is identified apply intensive trapping to eliminate remaining rodents . Gassing or fumigation may be useful in specific situations .
- Apply thorough Integrated Pest Management procedures (environmental hygiene , proofing and exclusion).
- Do not use anticoagulant rodenticides as permanent baits as routine . Use permanent baits only where there is a clear and identified risk of immigration or introduction or where protection is afforded to high risk areas .
- Record details of treatment.

APPLICATION OF AREA OR BLOCK RODENT CONTROL TO ELIMINATE RESISTANCE

- Where individual infestations are found to be resistant or contain resistant individuals it is possible that the resistance extends further to neighbouring properties.
- Where there are indications that resistance may be more extensive than a single infestation, apply area or block control rodent programmes.
- The area under such management should extend at least to the boundaries of the area of known resistance and ideally beyond.
- These programmes must be effectively coordinated and should encompass the procedures identified above.

APPENDIX

RRAC Checklist for Rodenticide Users Experiencing Difficulties.

Issued by RRAC. RRAC is a group formed by senior technical specialists within CropLife International. Members are BASF, Bayer CropScience, Liphatech S.A., Rentokil, Sorex and Syngenta. The committee would like to thank Adrian Meyer for facilitating the development of this advice.

The information contained in this monograph is accurate to the best of the knowledge of CropLife International, but no liability can be accepted whatsoever in respect of the use of this information nor in respect of any advice contained herein.

CropLife International
Avenue Louise 143
B - 1050 Brussels
Belgium

Tel +32 542 04 10
Fax +32 542 04 19

croplife@croplife.org
http://www.croplife.org